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TWO FUNGI GROWING IN HOLES MADE BY WOOD-BORING INSECTS.

BY PERLEY SPAULDING.

The relation existing between some of the fungi and the wood-boring insects is as yet but little understood and its significance is generally thought to be of slight importance. There are, however, strong and ever-increasing indications that its solution will form one of the most interesting chapters in the history of vegetable pathology, while the economic importance may prove to be much greater than is suspected at the present time.

The curious habitat of two of the fleshy fungi as observed in the southern pine district of eastern Texas has been very interesting to the writer because of the influence which insects were seen to exert upon the distribution of the fungi. In this section *Pinus palustris* is the tree which is almost exclusively cut for timber. Lumbering has been carried on within a year and there are large amounts of tops and small logs which were left to lie on the ground and rot. The bark has begun to fall off in many places but the wood can hardly be called rotten, although it shows the effects of beginning decay. This rotting material is the home of an immense number of wood-boring insects, of which one, making a hole about one-fourth inch in diameter, is present in every log in large numbers. On many of these rotting logs were growing numerous fungi of the Agaricus type and evidently belonging to two quite different species. Specimens have been very kindly identified by Professor Chas. H. Peck, who found them to be *Flammula sapineus* Fr. and *Claudopus nidulans* (Pers.) Pk. Nothing was thought of the matter until it was noticed quite accidentally that they were growing out of the holes made by the large wood-borer. It was found that the former fungus, *Flammula sapineus*, was present in larger numbers but both were plentiful. Many of the holes had no fungus growing in them, but with a single exception these two fungi were never found growing otherwise. This exception was a group of two or three individuals of *Flammula sapineus* which were found growing at the base of an upright but rotten pine tree. From their situation it was judged that they were growing on the rotted roots, but this was not ascertained. It was at first thought that the borers must have had something to do with the situation of the fungi, but everything seemed to discredit this supposition. On cutting the wood so that the interior was exposed it was found that the fungus mycelium invariably extended but a short distance into the burrows. In the burrows was always found a mass of wood fiber which had been chewed by the borer. This extended for several inches into the hole and was coarser the farther it was situated from the entrance. That located within about two inches of the entrance was more or less decayed and blackened. That situated farther in seemed to be perfectly sound and was uncolored. The pieces of material near the entrance were of the size of common sawdust while those located farthest from the entrance were often about one-fourth inch long. The mycelium was found only in the somewhat decayed material and never in the sound. The fungi seemed to feed on the decaying wood fiber, and apparently on nothing else. They are known as frequenters of decaying wood and this fact probably accounts for the limited distribution of their mycelium in the decayed outer portion and not in the fresh inner portion of the material. We apparently have a case where the spores of a previous crop of fungi were blown into the burrows and there germinated. They found their usual food material in sufficient quantities for them to complete their development and form fruiting organs. Immense numbers of spores were found under every specimen of *Flammula sapineus.* The amount of rotting material in any one burrow would not more than fill an ordinary teaspoon, yet the size of the specimens growing in the holes was about the same as that of those found on the ground and agrees well with published measurements. Frequently there were several growing out of the same hole, but in such cases their size was apt to be less than where there was but a single one. This, one would naturally expect because of the limited amount of food material. The two species never grew together in the same hole although they very often grew in adjacent ones only a few inches apart. Most of the specimens simply filled the hole with a mat of mycelium at the base of their stem, but in some cases the stem was swollen into a sort of shoulder which extended over the edges of the hole so that the latter was completely hidden. Small fruiting bodies of *Claudopus nidulans* were found occasionally inside the holes.

There are undoubtedly many similar instances of fungi growing in the burrows of wood-boring insects, although there are very few published accounts concerning them. Probably the most unique instance of fungi which either habitually or occasionally grow in such situations is that of the "Ambrosia" fungi.* Certain of the wood-boring beetles prepare tiny beds and plant the spores. So far as is now known these beetles feed exclusively on the fruiting portions of the fungi. These beds are located in the interior of the beetle galleries and are very carefully attended to. The fungi are very small and are saprophytes. *Polyporus volvatus* Pk. is said by von Schrenk † to grow on conifers in holes made by the bark-boring beetle *Dendroctonus* sp. The spores lodge in the holes and germinate. The wood is soon rotted by the mycelium of the fungus and the fruiting bodies are formed at the entrances of the holes. It is also stated by von Schrenk that this fungus occurs throughout the Northern States on coniferous trees, and, moreover, that it never occurs except in the beetle holes.* In the extreme west it is found on *Pseudotsuga douglasii* and *Sequoia sempervirens.* The latter tree is remarkably free from the attacks of fungi and would also be unaffected by this one were it not for these rather insignificant looking insects. *Polyporus pinicola* † also is known to gain entrance to trees by means of the holes of wood-boring insects. This is a particularly destructive wood-rotting fungus, and is responsible for much damage in lumber regions. In many cases there seems to be a direct relation between the distribution of the blueing fungus, *Ceratostomella pilifera* (Fr.) Wint., and the attacks of the wood-boring beetle, *Dendroctonus ponderosae*, on the wood of standing pine trees. Instances are also known where this fungus spread from the holes made by another wood-boring beetle.‡ Just what is the exact truth of the matter has not yet been determined in a satisfactory manner. As our knowledge of the fungi increases it is inevitable that many similar cases will be discovered.

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* Bull. Div. Ent., U. S. Dept. Agric. n. s. 7: 9–31. (1897.)

† Bull. Div. Veg. Phys. & Path., U. S. Dept. Agric. 25: 13–14. (1900.)

EXPLANATION OF PLATES.

From photographs by the writer.

Plate 25.— 1, View of a rotted log with *Flammula sapineus* growing in holes made by wood-borers. On the left side is seen a fungus growing out of a horizontal hole and showing the edges of the hole just below the stem. On either side are empty holes. 2, Specimen of *Flammula sapineus* in its natural position in the hole, slightly reduced. This gives a very good idea of the peculiar appearance of the fungi thus located. 3, Section of a log showing the character of the holes, the material contained therein, the extent of the mycelium into this material, and a group of three fungi, *Flammula sapineus*, growing from a single hole. The fungi are badly dried.

Plate 26.— 1, General appearance of a log with a specimen of *Flammula*

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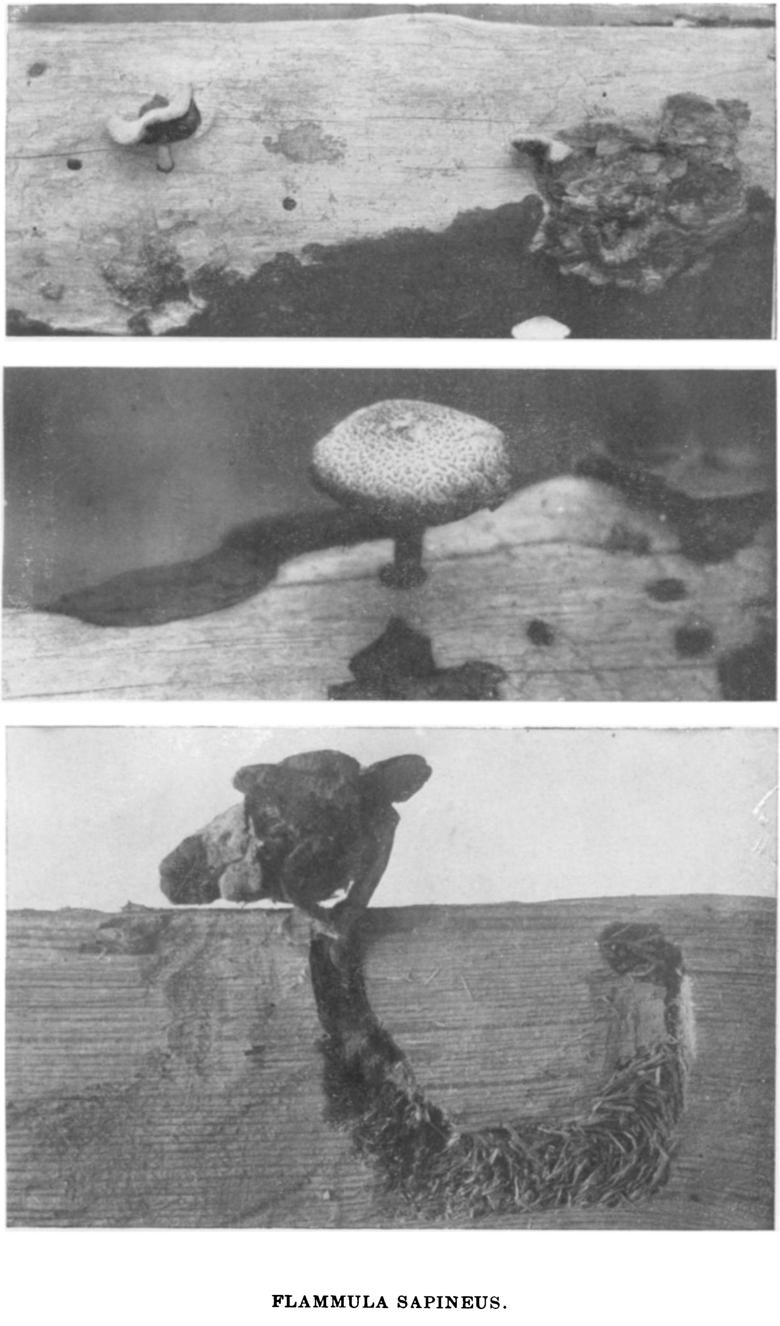
* MSS. in preparation.

† Bull. Div. Veg. Phys. & Path., U. S. Dept. Agric. 25: 14. (1900.)

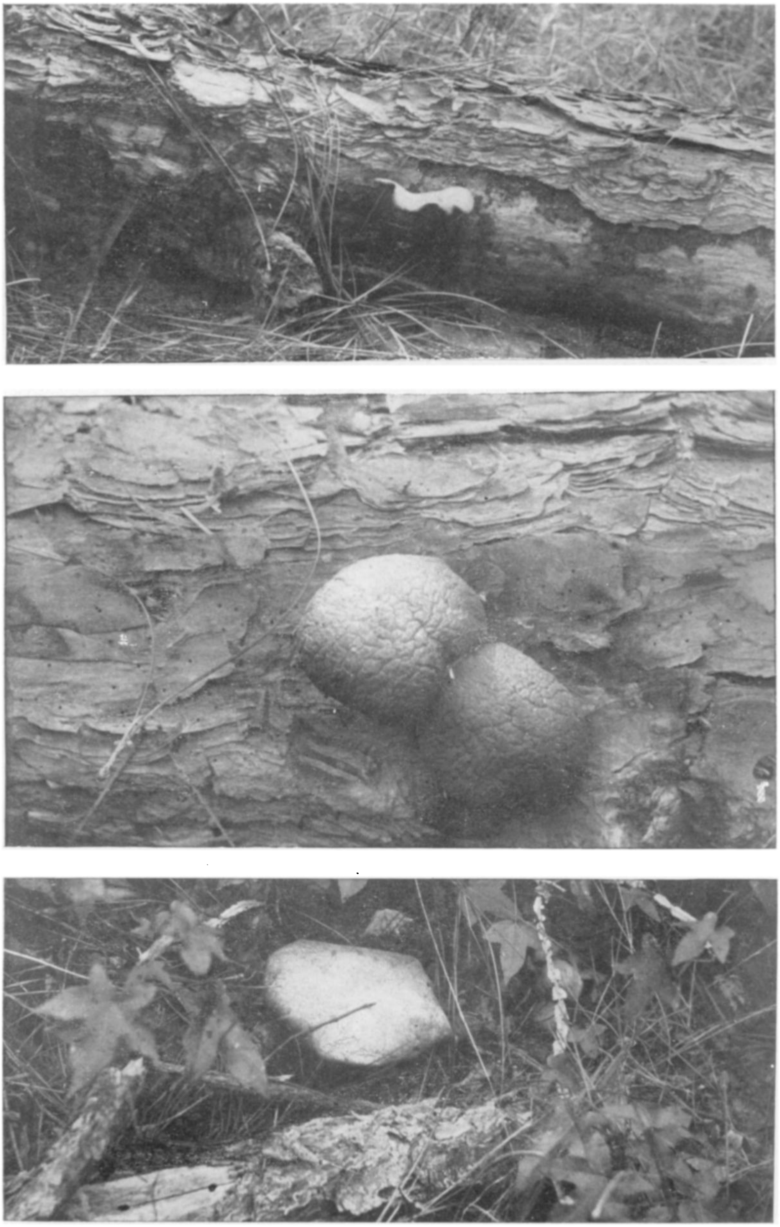
‡ Bull. Bureau Plant Industry, U. S. Dept. Agric. 36: 20. (1903.)

sapineus growing out of a hole. 2, Top view of three specimens of *Flammula sapineus* in a single hole. Taken at a distance of about four feet. Also shows the very numerous holes made by a small insect in the bark. 3, Specimen of *Flammula sapineus* growing on the ground at the foot of dead pine tree. Taken at a distance of about four feet. Compare with figure 2 of this plate.

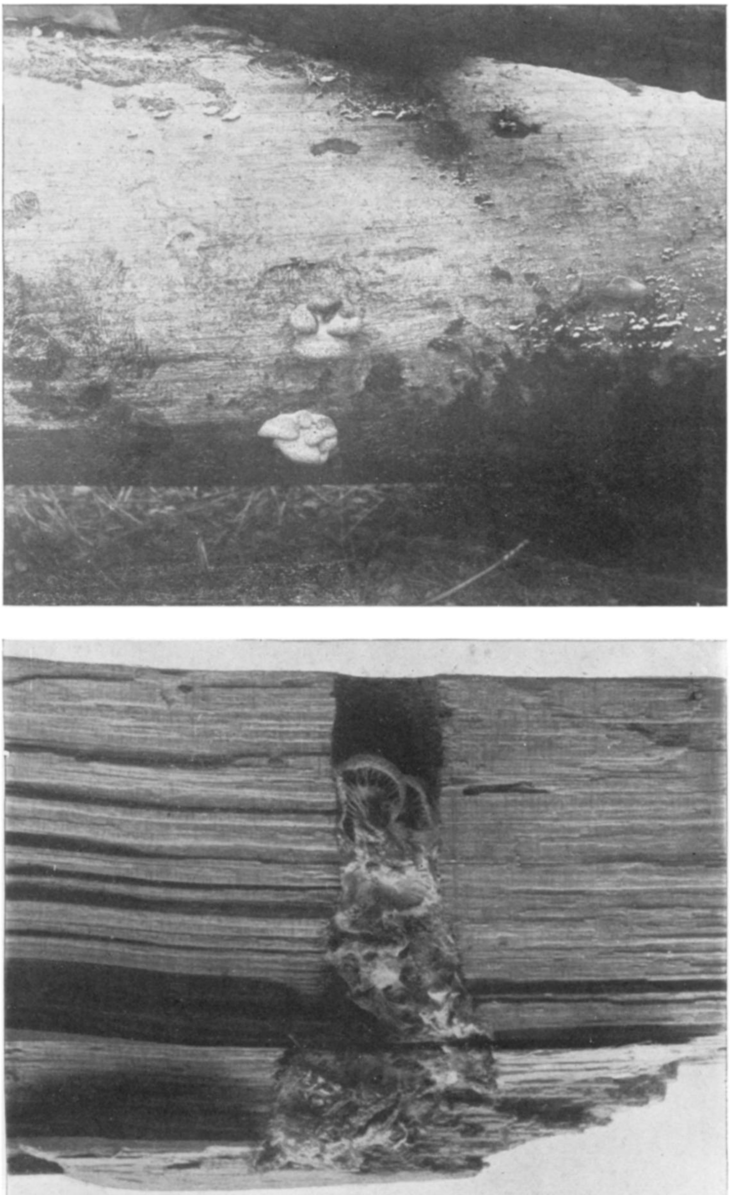
Plate 27.— 1, Compound fruiting bodies of *Claudopus nidulans* growing out of holes made by wood-borer in a rotting log. The compound fruiting bodies are rather scarce. At the right is seen a single one, which is the more common form. 2, Wood of log cut and split so as to show the interior of a hole which has some small specimens of *Claudopus nidulans* growing inside. Also shows most of the mycelium which was in this burrow.



FLAMMULA SAPINEUS.



FLAMMULA SAPINEUS.



CLAUDOPUS NIDULANO.